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ritions, with notes, is now ready for publication. This work not only contains a complete list of the best orbits of all the comets which have been computed, but also extensive notes relative to the physical phenomena, &c. which have been remarked in these bodies, along with copious references; it will thus be a complete manual of what is known on the subject up to the present time. I allude to these facts to show that it is not merely for the large pecuniary outlay which such an institution involves that astronomy is indebted to Mr. Cooper, but, in addition, for his personal and unwearied exertions."

On the Longitude of the Observatory of Durham, as found by Chronometric Comparisons in the Year 1851. By Mr. R. C. Carrington.

When the observatory was first established, in the year 1841, its approximate longitude was found by trigonometrical measurement of its distance west from the cathedral, as given in a general survey; and $6^m\ 18^s$ west, neglecting portions of a second, was adopted to start with: this value appears in the *Nautical Almanac.* By observations of the moon and moon-culminating stars in the years that followed, it was found that $6^m\ 19^s$ was nearer to the truth, but there still remained an uncertainty of more than half a second. At the last meeting of the Observatory Syndicate, in the year 1850, it was decided that a determination by chronometric comparison should be forthwith obtained. The Astronomer Royal was written to, and granted his permission for the necessary access to the transit-instrument at Greenwich; and application was made to Messrs. Reid, of Newcastle, for the chronometers. Six were sent, three pocket and three marine box-chronometers: the latter only were found, on trial, to be suitable for the purpose. They were received on Jan. 4, 1851, and rated daily till the 17th by comparison with the transit-clock. The first up-journey was made on the night of Jan. 17, the first down-journey on the 27th, by railway, the chronometers lying, in the interval, in the chronometer-room of the Royal Observatory, and rated daily along with those on trial for the Admiralty. I secured a sufficient number of clock-stars before leaving Durham, on arrival at Greenwich, before departure, and after arrival on the return; so that the first journey was rendered independent of personal equation. The second journey up was made by night mail-train on Feb. 4. I arrived at Greenwich on the 5th, at $2^h\ 1^m$, and returned to Durham the same night, the state of the sky at Greenwich giving no hopes of obtaining observations for clock-error. Transits were obtained at Durham on the 4th, before departure, and on the 6th, after return; so that the second journey is affected only by a slight uncertainty in the assumed rate of the transit-clock at Greenwich, and in the personal equation applied.

My personal equation was determined by the transit-observa-

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tions taken at Greenwich on Jan. 18 and 27, and is, as expressed in the Preface to the *Greenwich Observations*,

Dunkin — Carrington = $+ 0^{s}{\cdot}10$.

In the reduction it has not been attempted to determine travelling rates: it has been assumed that the vibration of the journeys caused equal deviations from the stationary rates of the time. The effect on the result, on this assumption, disappears in the mean of one up and one down-journey of the same chronometer. For the first journey two rates were employed, one for the up, another for the down-journey; for the second, one rate was found to be sufficient. These stationary rates were adopted from those immediately preceding and following the times of travelling. To the individual results weights were applied, inversely proportioned to the irregularities of rate of each chronometer, as follows :—

			m s		
First Journey, by Hornby...	771	West	6 20·16	Weight	1
— — Reid	1109	—	19·70	—	5
— — Harrison	476	—	19·84	—	1
		Mean, West	6 19·79		

			m s		
Second Journey, by Hornby...	771	West	6 19·63	Weight	1
— — — Reid	1109	—	19·71	—	2
— — — Harrison	476	—	19·78	—	2
		Mean, West	6 19·72		

The two results are considered to be of equal value, and

$6^{m}\ 19^{s}{\cdot}75$ West

is received as the final result, by chronometric comparison, for the longitude of Durham Observatory.

The three chronometers travelled in a deal box, well padded with horse-hair stuffing, made sufficiently low to go under the seat of a first-class railway carriage. The box rested steadily on three padded feet, and was carried between two men to and from all carriages. The chronometers were clamped in their gimbals while travelling, and appear to have been wonderfully little affected by the vibration they were subjected to. The calculations are preserved at full length at the observatory.

The communication of the result has been delayed since March 1851, in expectation of our being able to compare it with the geodetic longitude determined by the Ordnance Survey, but that result has not yet reached us.

P.S. Brorsen's Fifth Comet was carefully sought here on at least six different nights, but without success.

An Account of the Transit Circle at Mr. Drew's Observatory, Southampton, and of the Adjustments applied to it and to the Equatoreal. By Mr. Drew.

This transit circle is by Mr. Thomas Jones, and was made fifteen years ago. The telescope has 3¼ inches aperture, and 3½ feet

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focus; it will show the companion of *Polaris* in a dark field. The axis is 30 inches long, the Ys rest on stone piers, and the three microscopes for reading the divisions are fixed on a stone triangle at 120° from each other.

The telescope has five fixed transit wires, and one horizontal wire for north polar distance. This last is carried by a micrometer.

As the observatory is small and the instrument heavy (weighing about $1\frac{1}{2}$ cwt.), and as, from the arrangement of the microscopes, the reversal of the instrument would be inconvenient and dangerous, Mr. Drew has not attempted that operation. He thinks there may be some doubt as to the advantage of reversal in heavy instruments.

A collimating telescope of 1·6 inches aperture and 20 inches focal length is placed on a solid brick pier to the north, and outside the observatory, so as to be in the same line with the transit telescope, when horizontal. Mr. Drew does not find this much to be relied on as a *permanent* point of reference; but it is of great use for adjusting the instrument, considered as a well-defined mark. This collimator has a cover to protect it from the weather; and by opening a slide in front, and turning back the shutter behind to an angle of 45° (the shutter being whitened), distinct vision of the cross wires is obtained by day. At night the wires are illuminated.

To place the transit wires at right angles with the axis, it is sufficient to make the centre wire, through its whole length, pass over the cross of the collimator.

The intervals of the wires were determined by measuring them by the telescope and micrometer of the equatoreal (dismounted for that purpose), and also by transits of *δ Ursæ Minoris*. Mr. Drew gives a preference to the former method, which may admit of some question; but the two methods agree so fairly, that neither can be sensibly in error. The middle wire and the mean of the wires do not differ more than 0″·5.

In determining the error of collimation Mr. Drew has had more difficulty, and has not as yet been quite successful. He attempted to apply Bessel's method, viz., by taking out the object-glass and eye-piece of the transit telescope, and placing a telescope to the south of the instrument, in the same line with the collimator, so that the two are reciprocally collimators to each other. These being adjusted, and the object-glass and eye-piece inserted in the transit telescope — if the centre wire of the transit be made to bisect the wires of both the collimators, the collimation error is destroyed. From some want of steadiness in the position of the southern telescope, the attempt did not succeed; but Mr. Drew observes that this would be worth a trial with both telescopes on fixed piers.*

There are two ways of ascertaining the horizontality of the transit axis: first, by applying the level in the usual manner, which

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* As in the Greenwich transit circle.

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implies, however, that the pivots are equal; and secondly, by observing the coincidence of the central transit wire with its image seen in a mercurial horizon,* which also implies that the error of collimation is destroyed. Though the errors follow different laws, it would not be easy to separate them, very nicely, by observation. It is not probable that in a carefully-made instrument the difference of the pivots should be large, as the grinders ought to be used alternately for each; but without reversal, or without two collimators, it does not seem practicable to assign the relative errors correctly by the means adopted, unless the equality of the pivots can be assumed.† Mr. Drew has applied his level, and observed the coincidence of the transit wire with the image; the collimation, therefore, must correspond to the difference of the radii of the pivots, and cannot well be large enough to affect the accuracy of ordinary observations.

The meridian error is deduced, as usual, by observations of the upper and lower culminations of *Polaris*, and by opposite culminations of δ *Ursæ Minoris* and *Cephei* 51 Hev.

A specimen of the clock-errors, deduced from standard stars at different north polar distances, shows that the time at Mr. Drew's observatory is obtained with great accuracy.

In using the transit circle as an instrument for determining north polar distances, Mr. Drew relies on the nadir point, as determined by the coincidence of the horizontal line and its image seen by reflexion. He speaks with great confidence of the steadiness and consistency of this determination. The latitude of his observatory, deduced in this way from 9 Greenwich stars, is $50^\circ 54' 34''\cdot4$ N., probable error $0''\cdot42$; while the latitude derived from a triangulation connecting his observatory with the Ordnance Map Office gives $50^\circ 54' 34''$. (The longitude, derived in the same manner from the Map-Office data, is $1^\circ 24' 25''\cdot8$ W.‡)

Mr. Drew gives a brief account of the manner in which he has adjusted his equatoreal; as nearly, that is, as the instrumental readings enabled him.

The altitude of the polar axis, and the collimation of the telescope in polar distance, are corrected by observations of standard stars near the meridian, and in reversed positions of the instrument. The azimuth is set right by making the instrumental polar distances of standard stars six hours from the meridian§ agree with their tabular north polar distances.

The error of collimation in right ascension is obtained by observing the passage of stars near the equinoctial over the central

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* Mr. Drew's instrument is provided with the proper eye-piece for this observation, and the means of illumination both by day and night.

† A guage might show the equality of the pivots, and *perhaps* measure their difference.

‡ The Ordnance Survey Longitudes, since a more correct figure of the earth has been adopted, seem to agree perfectly with the best astronomical data. See the "Memoir of the Astronomer Royal on the Longitude of Valentia," *Mem. Royal Ast. Soc.*, vol. xvi. p. 55.

§ Correcting, of course, for refraction, which is always supposed. Mr. Drew has given a formula for the effects of refraction, but it does not appear so convenient as that adopted in the Greenwich Observations.

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transit wire, in reversed positions. A comparison of the intervals of the transits in the two positions with the difference of the readings of the hour-circle, gives the correction of the collimation; and if the stars are standard, and the error of the clock known, the correction of the verniers of the hour-circle may be deduced from the same observations. Finally, the squareness of the declination axis to the polar axis* is proved by ascertaining, whether stars which differ in polar distance give the same clock-error. By applying these precepts in order, Mr. Drew shows that he has been able to put his equatoreal into as perfect a state of adjustment as he has means for ascertaining its errors.

Letter from the Rev. Mr. Read respecting the Luminous Bodies seen on Sept. 4, 1850. (See *Monthly Notices*, vol. xi. p. 48.)

"At the suggestion of several eminent members of the Society, I beg again to call your attention to the account of the phenomenon of shooting stars, as seen by myself and my family, in the day time, on the 4th of September, 1850.

"My former communication, which appeared in the *Monthly Notice* of December 1850, was a very brief one, and was only intended to call forth the observations of others, had any such been made; and I omitted then, purposely, to append any attestation of those who witnessed it with me, or to state anything that might be unnecessary, in the hope that more full accounts might be furnished.

"I have, however, now laid before the Council such necessary attestations; and, in addition, offer a few such particulars as seem necessary to render my former communication more complete.

"I have myself been a diligent observer for about twenty-eight years, with instruments of a superior order; but I never witnessed any such appearance before.

"The occasion of my being in the way of seeing so remarkable a phenomenon was, that I had been engaged for several previous days, in succession, in observing with my equatoreal the planet *Mercury*, in order to ascertain how nearly I could trace his approach to the sun; and it was the first instant that I adjusted the instrument that I saw the appearance which I describe.

"I was, at first, filled with surprise, and endeavoured to account for what I saw by supposing that bodies were floating in the atmosphere; but nothing was visible to the naked eye, while the sky was perfectly cloudless and serene: the ceaseless passing of perfect spheres of light in uncountable numbers soon convinced me of the reality of the phenomenon, and I called in haste the various members of my family to witness it, which they did, with me, for many hours.

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* Careful artists frequently make this adjustment themselves, and leave no power of alteration. When the polar axis is vertical, it is easy to make the declination axis horizontal; and when all the parts are sound and the work true, this adjustment is not likely to be altered. The application of a level is seldom convenient for a mounted equatoreal, but this adjustment may be performed by a level.